Review

Recent Advances in Cereal Oil Processing Technology

*By Yasuhiko Takeshita**

Synopsis: Between 30 years at which the author belonged to the national technical committee of rice bran oil industry as a staff or chairman, Japanese rice bran oil industry developed and situated at the top of the world in the point of quality and scale. Author discusses the recent technical advances of this field. The oil extracting process, which was generally hydraulic press was changed to batch or battery type solvent extracting methods at the first step, and secondary developed to continuous process. The pelletizing of raw rice bran was eliminated, and special cooking process coagulating and eliminating the fine particles of rice bran, was developed. By this improvement, plant capacity was enlarged. The solvent fractionation and refining for edible oil was also developed, and oryzanol, inositol and tocopherol as byproducts were produced.

L'extrait: Nouveaux Procédés dans la Fabrication de l'Huile du la Céréales

Au cours de 30 années, pendant lesquelles l'auteur était le membre ou le président du comité national de l'industrie de la fabrication de l'huile du son de riz, l'industrie japonaise de la fabrication de l'huile du son de riz s'est développée et elle a atteint la cime mondiale dans la qualité et aussi dans le volume de la production.

L'auteur discute des nouveaux cusses techniques dans ce domaine. Le procédé de l'extraction d'huile, qui a été en général effectué aux presses hydrauliques, est transformé en extraction ã l'aide des solvants, d'abord continument ou dans les batteries, plus tard on a développé des procédés continus. On a éliminé le pelotage du son brut de riz et on a développé le procédé spécial de cuisson, au cours duquel les particules fines du son de riz ont été coagulées et éliminées. Ces améliorations ont rendu possible l'augmentation de la capacité de l'équipment de production. On a aussi développé le fractionnement ã l'aide des solvants et le raffinage pour les huiles comestibles; en qualité des produits secondaires on a obtenu l'oryzanol, l'inositol et le tocophérol.

1. INTRODUCTION

Energy and resources utilization are two important problems confronting the present age. A possible solution to this problem is the development of the vegetable oil industry to meet both the continuing demand for edible oil and the utilization of vegetable oils as an alternative to fossil energy, which in the future will be of short supply. The most efficient and practical energy resources alternative may be a biomass fuel composed of wood or vegetable oils. Vegetable oil seeds are relatively easy to cultivate and to harvest, and production can be adjusted to correspond to the demand of both the local and international markets. The bran and germ of cereal materials, such as rice, corn and wheat which are widely consumed in the world as a staple food, are commonly considered as a mere by-product of the milling or polishing operation.

Industrially, the main cereal oil material is rice bran, which has a germ content of about 30%. The total yield of rice bran from paddy is about 7%, and from brown rice, about 10%.

In Japan, nearly 100 thousands metric tons of rice bran oil are produced annually; however the production of oil from the other cereals is much smaller, excluding corn germ oil production ca. 70 thousands tons in 1981. Even though the other cereal oils are not produced in any significant amounts, some of them, such as wheat germ and rice germ when isolated

* Professor, Chem. Lab.,
Dr. of Engin., Consulting Engin.

from their respective bran, are important as a natural source of tocopherol.

Internationally, rice bran oil production in India or China has grown greater than in Japan during the past ten years. However, solvent extracting and refining technologies were best modernized in Japan, developing this industry earliest in the world.

The industrial processing method most suitable for the various oil-bearing cereals depends on both the type of cereal and the size of the plant. Mechanical expression followed by solvent extraction is the usual practice in plants processing wet milled corn germ, which has the oil content of about 50%. Dry milled corn germ, wheat germ and rice bran are normally directly solvent extracted, because those materials have low oil content less than 20%.

Rice bran in Japan, the only domestically produced oil-bearing material, has an oil content of about 19%, which is equal to the oil content of soybean—the most important oil seed in the world. Due to the fact that rice bran is naturally fine particle, special equipment is required in order to process it in continuous solvent extraction plants. At the soybean oil extraction, a slight conditioning of flake has been developed by M. Kock & G. Penk[9] recently. However, rice bran requires a different type of preparation process to prevent any fine problems. The ideal preparation process is one which can meet both the technical requirement of agglomerating the rice bran to a suitable size and the financial requirement of being inexpensive.

Pelletizing, flaking[7),10)] or slight agglomeration[5),6)] by pressure, moisture and heat treatment of rice bran are some of the alternatives developed by researchers and manufacturers, and are being utilized on a commercial basis of large scale continuous extraction industry of rice bran oil.

The free fatty acid (ffa) of raw rice bran increases rapidly after milling, finally to ca. 75%[2)]. To prevent this, a process called sterilization or stabilizing was researched.

The author discovered double acid values (AV) of cereal oils, and AV by alkali blue-6B or BPB indicator corresponds to ffa[2)], however AV by phenolphthalein is owed further more to phenolic matter as a characteristic component. This property has an influence on cereal oils edible refining, especially on final AV industrially.

Oils mills designed for wheat germ, rice germ and pearl barley are rare in Japan; therefore, oil from these cereals are produced only on a minor scale.

The recent advances in rice bran oil processing will be the main theme of this paper, consequently the other cereal oil industries will only be very briefly discussed.

2. TECHNICAL ADVANCES IN RICE BRAN OIL PROCESSING

In 1971, the author discussed this theme at the UNIDO Rice Seminar[1)], and stated at that time that continuous solvent extraction based on rice bran was rare in Japan and that the pelletizing of rice bran required too much energy.

The author also pointed out that it was difficult to establish larger scale continuous solvent extraction plants for rice bran, because the preparation of fine raw rice bran was not economical.

However, in countries where the rice milling system is different from Japan and the size of the bran particle is extremely small, the cost of pelletizing is more favorable to the total financial balance of the plant inversely. Lurgi, De Smet and French Oil Mill Machinery Co. are some of the companies that have adapted cooking and pelletizing or so called sterirization.

2.1 Cooking and Pelletizing Method

Cooking is performed in a horizontal cylindrical vessel or a multi steps kettle equipped with usually a steam jacket and a stirer. After cooking, the hot and some wet rice bran is pelletized in a Buhler type pellet machine with die and rolls. The pellets usually contain some moisture and have a diameter of 2–8 mm, and are adaptable for solvent extraction. However, the main disadvantages of this process are the short life of the die and roll, and the power consumption of the pelletizing unit in spite of its small capacity. Specifically, the life of the die is about 1 month; the roll, 2 weeks; and for pelletizing about 2 ton/h a motor of 40–50 HP is required.

Anderson Co. (U.S.A.) developed the "Expandolex System"[7] which was composed of a cooker, flaker or extruder. After sifting, the rice bran is cooked with water and steam, and then extruded with the aid of moisture and heat of friction to the suitable dimention. In this process rice bran is molded, sterilized and expanded. (see **Fig. 1**)

Presently, pelletizing and flaking are being evaluated as a possible means to mecanically stabilize the rice bran instead of as a possible pretreatment for solvent extraction[10].

2.2 Classical Preparation Method

In Japan, the pot press had been initially utilized to mechanically extract rice bran oil. The rice bran was prepared by pressure cooking which was designed to destroy the cells of the bran in order to ease the expulsion of oil. The crude oil yield improved to about 13%. For solvent extraction, cooking and drying were usually performed because they both improved the yield of crude oil and the desolventizing of the defatted rice bran. The author has previously reported on the optimum moisture content of rice bran prior to solvent extraction[12].

Raw rice bran is a fine powder with a normal moisture content, 12–13%. Solvent extraction of rice bran without proper preparation and in a thick bed is difficult because the

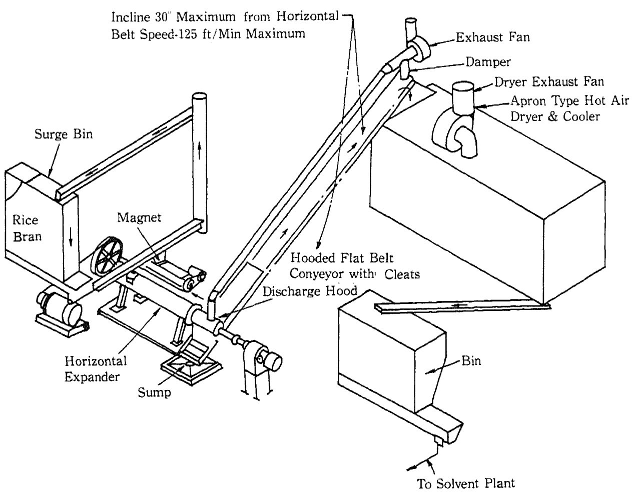


Fig. 1–1 Process for Preparing Rice Bran for Solvent-Extraction[7] —Refered to Anderson Co. Booklet—

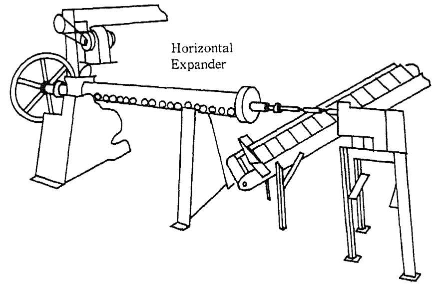


Fig. 1–2 Exterior view of a typycal Anderson horizontal grain expander[7]

percolation of miscella is slow, and finishing of desolventizing by live steam is difficult.

The disadvantage of the cooking and drying process is that it requires much steam. For example, to remove 10% moisture from rice bran by evaporation in a horizontal steam jacketed dryer, about 20% steam is required. An improved process requiring a low steam consumption was offered by K. Shida[4], that is direct solvent extraction of raw rice bran without cooking, however it was not industrially adopted in Japan. The author supposed the cause as a difficulty of scale up of the plant.

2.3 Agglomeration of Rice bran by Hot Hydrating or Granulating Device

Agglomeration of rice bran is completed only when suitable moisture and heat are supplied in a cooker or extruder. An ordinary pellet machine utilizes about 20 HP per ton per hour capacity for pelletizing steamed rice bran. If the moisture content of the rice bran is increased, the electrical consumption of the pelletizer is gradually reduced, and rice bran is easily

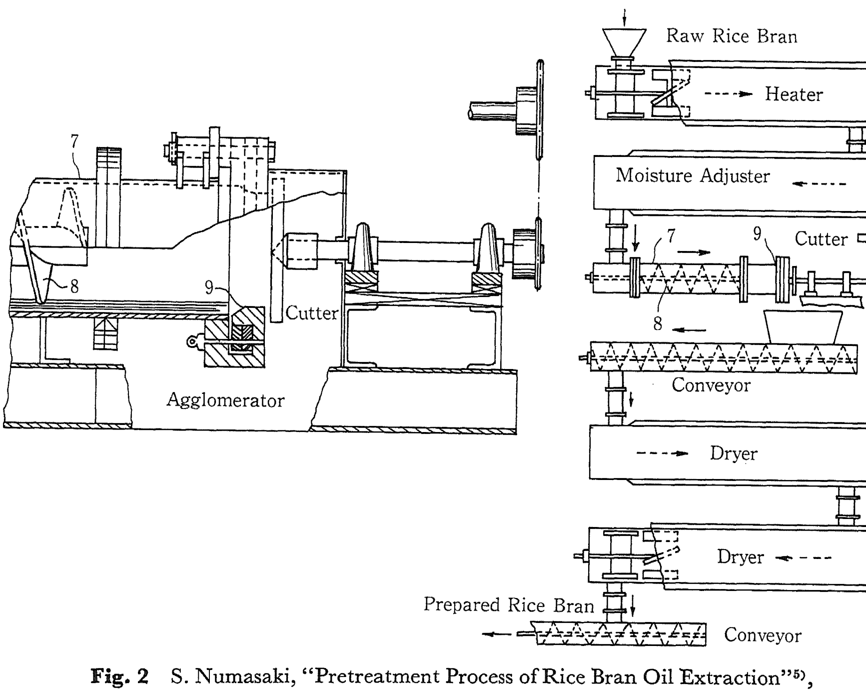


Fig. 2 S. Numasaki, "Pretreatment Process of Rice Bran Oil Extraction"[5], —Courtesy the Inventor—

agglomerated by the pasty starch component of it. S. Numasaki and Sakakura[5] have proposed rice bran preparation by a simple process consuming very little electricity. A 2～3 HP motor is required for processing 1.25 ton per hour of rice bran with the addition of 2% water and heating (**Fig. 2**). In addition, fine particles of less than 80 mesh are eliminated, and the peak of the size distribution curve is shifted from 80 mesh to 60 mesh. The process requiring a small electric motor, which has power requirement of 10% to the ordinary pelletizer and an easily exchangeable press head parts. Furthermore, maintenance of the equipment is repeated very easily. This process has improved the batch extraction process data for steam consumption, solvent loss and rice bran charge capacity, thus as a result it is is some similar to the Anderson's Expandolex System, however, it has the advantage of

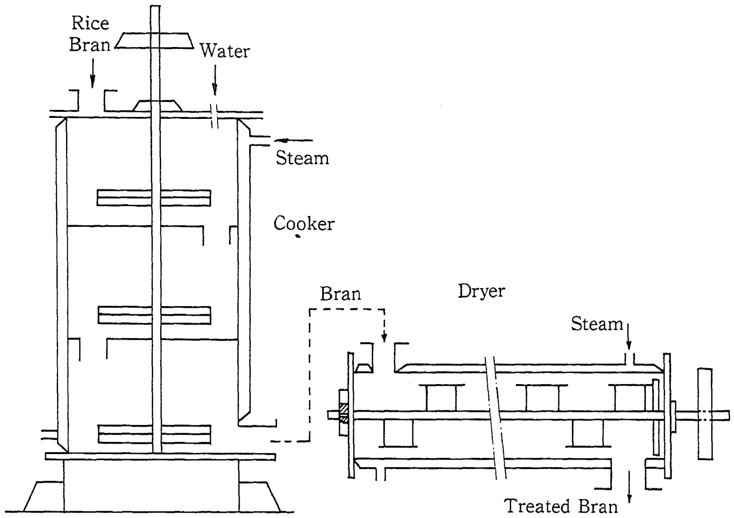


Fig. 3 Cooking Agglomerator by Yoshino seisakusho Co. Ltd.

very popular in Japan. The author has discussed this process in detail in a previous review[13].

Yoshino Seisakusho Co., Ltd. et al.[6], see **Fig. 3**, invented a soft agglomerating method which did not require any pressing. The moisture content of rice bran, which is initially less than 20%, is adjusted in the cooker and then dried. This process completely eliminates any fine particles, and enables the processing of rice bran in large capacity continouous solvent extraction plants. Approximately ten of these Large scale Yoshino-type continuous solvent extraction plants are operating in Japan, and they have been getting increasing attention from overseas. The author introduced this plant also in a previous report[13].

2.4 Stabilizing of Rice Bran

A lot of reports about stabilizing were published historically that is Y. Tsujino[22], U. Myint Pe[21] and R. V. Enochian et al.[10]. In spite of success of complete stabilizing in laboratories, industrial stabilizing for long period has still incomplete factor[11]. The hot storing without flaking or agglomerating in atmosphere deteriorates the lipid of stabilized bran surface, as p-Anisidine Value raises gradually. Therefore, stabilizing by mechanical pressing was evaluated recently[10]. However, these processes still have not been developed to the point where complete stabilization is achieved industrially, in spite of easily stabilizing in comparatively small scale. In Japan, stabilization is not practiced because most of the rice bran oil mills are located not so far from rice mills generally, and are making the effort to process the fresh bran by all means, in spite of completion of stabilizing study[22].

2.5 New Extraction Method (NEM)

The New Extraction Method or NEM, see **Fig. 4 & 5**, is a new rice bran solvent extraction process developed by Oryza Oil and Fat Chemical Industry Co., Ltd. (Japan)[8] This process involves the solvent extraction of raw, non-cooked rice bran. The advantages of this process are that it has a low cost and produces a superior quality dewaxed crude oil at an increased quantity compared with the conventional solvent extraction methods. During the preparation process the rice bran is not cooked as in the conventional process but is prepared in a specially designed press machine, adjusted to the proper temperature, and then charged into the solvent extractor which is operated at a low temperature—approximately 25 °C. The crude oil from this process has a light color, and a low wax content, consequently, the conventional solvent dewaxing process is not required.

The typical figures for the NEM are as follows:

a. steam consumption ....280 kg/feed metric ton of rice bran
b. solvent loss ....0.6 liter/feed ton of rice bran
c. residual oil in the defatted meal ....less than 1%

By comparison, the typical figures for the conventional plant are as follows:

a. steam consumption ....400 kg/feed ton of rice bran
b. solvent loss ....1 ~ 2 liter/feed ton of rice bran

A general description of the NEM was presented by the author at 7th World congress "Cereal '82" in Prague. The utilization of the cold press or extraction and flake or pellet

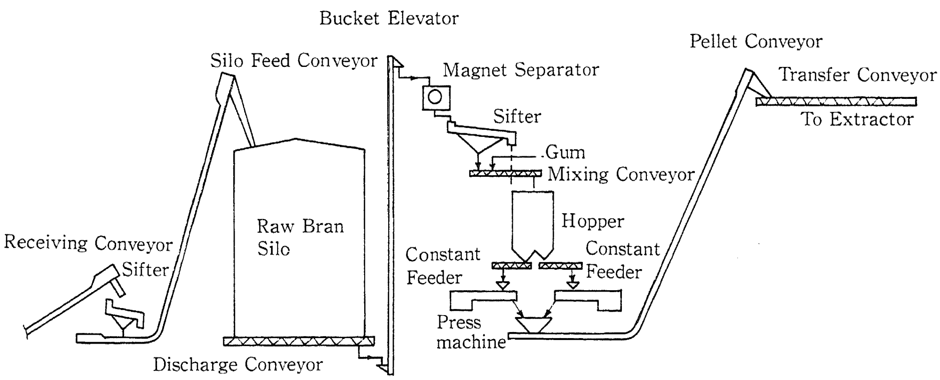
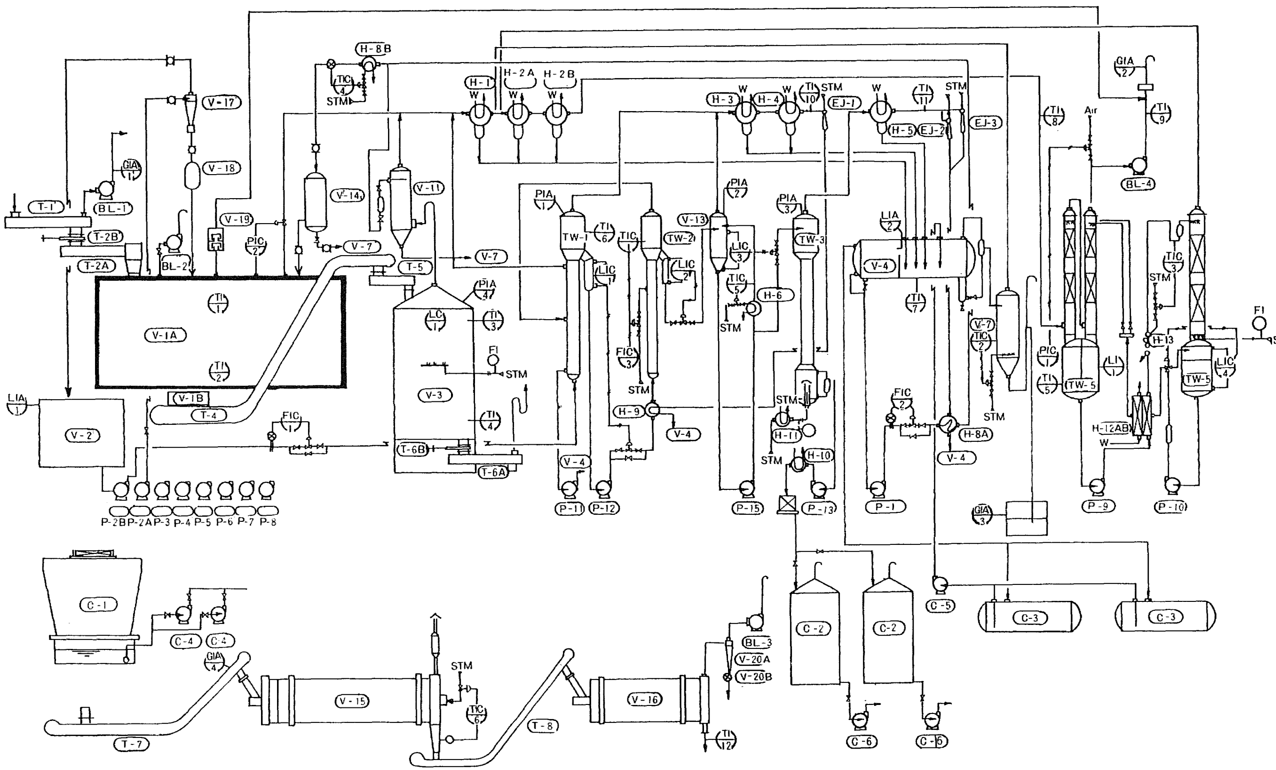


Fig. 5 N.E.M. Preparation Process of Rice Bran (Courtesy Yoshinoseisakusho Co. Ltd.)

extraction of fine particles have been independently utilized over the world in the oil industry; however, the simultaneous application of both methods in the rice bran oil industry is quite new. The NEM can be considered to be the most modernized and up-to-date method for processing rice bran.

Another advantage of the NEM is its fuel and energy conservation features. Prior to processing in the press machine, the rice bran is mixed with the waste oil-sludge from the degumming process which includes several percentage of oil and water in order to soften and lubricate it. As a result, the electric power required for the press machine and temperature raising are reduced. (**Fig. 5**)

The NEM, which is covered by an international patent held by S. Murai et al. of Oryza Oil and Fat Industry (Yuka) Co., Ltd. [8], required much research and development to perfect, but is now being offered to prospective customers both in Japan and overseas.



TEMPERATURE

TIC-1 90℃
TIC-2 95℃
TIC-3 120℃
TIC-4 63℃
TIC-5 90…100℃
TIC-6 60…70℃
TI-1 55…60℃
TI-2 55…60℃
TI-3 55…60℃
TI-4 105℃
TI-5 35…45℃
TI-6 50…60℃
TI-7 50℃
TI-8 0…40℃
TI-9 0…40℃
TI-10 0…40℃
TI-11 0…40℃
TI-12 0…50℃

PRESSURE

PIC-1 0…−200mmAg
PIC-2 ±200mmAg

TW-1 350mmHga
TW-2 760mmHga
V-13 350mmHga
TW-3 150…200mmHga

Utility (per feed ton)

Steam : 260.300kg
Water : 10-13 tons
Solvent loss : 1 ltr-3ltr
Residual oil : 0.5%

T-1	Feed Conveyer
T-2B	Slide Gate
T-2A	Seal Conveyer
V-1A	Extractor
V-1B	Discharge Conveyer of Extractor
T-4	Extracted Flake Elevator
T-5	Feed Conveyer of Desolventizer
V-3	Desolventizer
T-6A	Meal Dischange Conveyer of Desolventizer
T-6B	Slide Gate
P-2A	Miscella Pump
P-2B	Miscella Transfer Pump
P-3	No.1 Stage Pump
P-4	No.2 Stage Pump
P-5	No.3 Stage Pump
P-6	No.4 Stage Pump
P-7	No.5 Stage Pump
P-8	No.6 Stage Pump
V-11	Wet Scrubber
BL-1	Ventilator of Feed Conveyer
BL-2	Purge Blower
V-2	Miscella tank
V-19	Safety Seal
V-17	Liquid Cyclone
V-18	Fine Receiver
T-7	Toasted Flake Elevator
V-15	Meal Dryer
T-8	Dry Meal Elevator
V-16	Meal Cooler
V-20A	Cooler Cyclone
V-20B	Cyclone Lock
BL-3	Cooler Blower
TW-1	First Evaporator
TW-2	Second Evaporator
TW-3	Oil Stripper
H-9	Miscella Heater
H-8A	Solvent preheater
H-8B	Solvent Heater
H-1	First Gas Condenser
H-2A	Second Gas Condenser
H-2B	Vent Condenser
H-3	First Condenser of Evaporator
H-4	Second Condenser of Evaporator
H-5	Oil Stripper Condenser
H-11	Steam Super Heater
V-7	Water Stripper
V-4	Solvent Decanter
TW-4	Recovery Absorber
TW-5	Recovery Stripper
H-12A	Recovery Interchanger
H-12B	Recovery Interchanger
H-13	Recovery Heater
EJ-1	Evaporator Ejector
EJ-2,3	Oil Stripper Ejector
V-13	Flush Tank
H-6	Flush Heater
BL-4	Vent Blower
P-12	Second Evaporator Feed Pump
P-15	Oil Stripper Feed Pump
P-13	Oil Discharge Pump
P-11	Steam Condensate Discharge Pump of First Evaporator
P-1	Solvent Transfer Pump
P-9	Rich Oil Pump
P-10	Lean Oil Pump
C-1	Cooling Tower
C-2	Crude Oil Storage Tank
C-3	Hexane Storage Tank
C-4	Cooling Water Transfer Pump
C-5	Hexane Transfer Pump
C-6	Crude Oil Transfer Pump

Fig. 4 Rice-Bran Oil Continuous Extracting Plant Flow sheet (by the courtesy of Yoshino Seisakusho Co. Ltd.)

3. CORN AND WHEAT GERM OIL INDUSTRIES

Corn germ, which is separated by the dry milling of corn, has an oil content in the range of 10～20% which varies depending on the species of the plant[20]. This is considered a low oil content corn germ, and is suitable for direct solvent extraction after flaking to a thickness of ca. 0.2 mm. Dry milling yields about 10% corn germ, and wet milling, about 5% which contain ca. 50% oil. The ffa content increases by the action of a natural enzyme, therefore it should not be stored for a long period. A ffa in the range of 10 to 20% is common in dry milled corn germ. The necessity of eliminating hot spots in stored corn germ is common, and especially with high moisture content corn germ stored in silos.

In east Africa, where corn flour is a staple food, dry milled corn germ is the main oilbearing material. Around 3,000 metric tons of edible corn oil was produced in Kenya in 1981. A Japanese mission including the author studied the feasibility of producing edible oil at the request of the government in August 1982.

Wheat germ oil is a natural source of Vitamin E. The industrial production of this oil has been expanding in the last few years in Japan. The author has assisted in the development of the solvent extraction and refining of this oil. Commercial wheat germ has an oil content of less than 20% and a ffa in the range of 10–20%.

At present, the production of wheat germ oil is limited due to the requirement for improvement in the extraction technology. Wheat germ oil contains more β-tocopherol than rice germ oil which contains mainly d-α-tocopherol or corn germ oil. **Table 1** shows the Vitamin E content of various vegetable oils. Further work on tocopherols and tocotrienols in cereals has been reported by A. Kato[15].

Table 1 Vitamin E contents in mg% of various vegetable oils[16]

	Tocopherols				
	Total	α–	β–	γ–	δ–
Cereal Oils					
Rice Germ Oil	195	163	7	23	1
Rice Bran Oil	89	63	—	26	—
Corn Germ Oil	102	13	—	89	—
Wheat Germ Oil	192	118	74	—	—
Contrast					
Soybean Oil	95	9	—	63	23
Rapeseed Oil	46	13	—	25	8
Safflower Oil	41	34	—	7	—

Tocopherols have already been industrially synthesized, but natural tocopherols are concentrated from the distillate of the deodorizing process of edible vegetable oils. Its main use is as a health food and a natural antioxidant. In Japan, tocopherol is not required to be labeled as an artificial food additive.

Pearl barley has been designated as a pharmaceutical product and health food, however its production as an alternative to rice in Japan, has not received much industrial application. Only academic research on pearl barley bran has been performed with little technical progress. The author has previously reported on the latest research in this field and the tocopherol characteristics of each part of pearl barley bran and husk[17].

Oryzanol[18] and inositol[19] are two of the by-products of the rice bran oil industry and their production has been increasing yearly in Japan. Inositol is produced from the defatted rice bran, however in western countries it is mainly produced from corn steap liquor. Rice protein and dietary fibre from rice bran have been researched, but their manufacturing cost and possible pollution problems have hindered its development.

4. CONCLUSION

The author presented the main contents of this paper at "Cereals '82 in Prague" and also contributed the following abstract to the conference. "Between the thirty years that the author belonged to the national technical committee of the rice bran oil industry as either a staff member or chairman, the Japanese rice bran oil industry developed and attained the highest level in the world in terms of both quality and scale.

The author discussed the recent technical advances in this field. The rice bran oil industry which began with the hydraulic press, then progressed to the batch or battery type solvent extraction method, has now fully advanced to the continuous solvent extraction process. The elimination of pelletization, and the development of a special cooking process to coagulate and eliminate fine particles has enabled the realization of large scale solvent extraction plants to be utilized in the rice bran oil industry. Solvent fractionation and the refining of edible oil have also been improved and developed; and valuable by-products, such as oryzanol, tocopherol and inositol have been produced."

Acknowledgements

The main content of this paper was presented to 7th World Cereal & Bread Congress, Prague, Czechoslovakia, June 28 ~ July 2, (1982). The author thanks Mr. S. Yoshino, Mr. S. Murai, Dr. & Mrs. Barber for providing necessary literatures or discussing, and President B. Shibata of Kokushikan Univ. for financial aid. The author acknowledges the valuable assistance of Mr. Eugene M. Tsuji in the editing of this article.

(Received, Sept. 18, 1982)

References:

1) Y. Takeshita, "Technical Advances in Rice Bran Oil Processing" Transact. of the Kokushikan Univ. Dept. of Eng. No. 5, p. 1 (1972)
2) Y. Takeshita, H. Yoshida and M. Y. Rai, "Global Trend of the Oil Bearing Materials and Oil & Fat Technology" ibid. No. 14, p. 86 (1981); Y. Takeshita & O. Okubo, "An Improved Method for the Acid Values of Rice Bran Oil and its Identification" ibid. No. 14, p. 20 (1981)
3) Y. Takeshita, Preprint of Cereals '82 in Prague, p. 181 (1982)
4) K. Shida, Japan Pat. No. 185363 (1950. Dec. 11)
5) Numasaki, "Pretreament Process of Rice Bran Oil Solvent Extraction" Japan Kokai, S. 53–14707 '78, Feb. 9
6) Yoshino Seisakusho Co. Ltd. "Pretreatment of Rice Bran" Japan Pat. pending.

7) M. Williams & S. Baer, "Expansion & Extraction of Rice Bran" J. Am. Oil Chem. Soc., **42**, 151 (1965)
8) Oryza Yuka Co. "New Extraction Method" Japan Pat. and International Pat. pending, PCT/JP 78/00032 (21-11-1978); Yushi, **35**, (2) 49 (1982)
9) M. Kock, "Grundlagen zur Qualitätssteigerung von Sojaöl durch Behandlung der Sojaflochen vor der Extraction" Fette. Seifen. Anstrichm. **83**, A 552 (1981); G. Penk, ibid. 558 ('81)
10) R. V. Enochian, R. M. Saunders, W. G. Schultz, E. C. Beagle and P. R. Crowley, "Stabilization of Rice Bran with Extruder Cookers and Recovery of Edible Oil"—A preliminary analysis of Operation and Financial Feasibility——Marketing Research Report, No. 1120, USDA, Agricultural Research Service (Nov. 1981)
11) S. Barber & C. B. de Barber, "Improvement of Rice Bran for Better Utilization of its Lipid Fraction" to be presented at the "Cereal Lipids Symposium", 7th World Cereal & Bread Congress, Prague, Czechoslovakia, June 28–July 2 (1982)
12) Y. Takeshita et al., "Utilization of Rice Bran Oil IV, The Solvent Extraction of Rice Bran Oil". J. of J. Oil Chem. Soc., (Yukagaku), **11**, 5 (1962)
13) Y. Takeshita, "Recent Advances in Oil Extracting & Refining Technology" J. of J. Oil Chem. Soc., (Yukagaku), **27**, 13, (1978)
14) Y. Takeshita, "Technical Investigation Report of Overseas Rice Bran Oil Industry.—a feasibility study of rice bran oil industry in mid-Thailand & Upper Malaya-peninsula"—Transact. of the Kokushikan Univ. Dept. of Eng. No. 8, p. 55 (1975)
15) A. Kato et al., "Esterified Tocopherols & Tocotrienols in Rice Bran Oil, Soybean Oil and Sesame Oil" J. of J. Oil Chem. Soc., (Yukagaku), **30**, 515 (1981); Kagiken, Report, **77**, (4) 219–222 ('82)
16) Y. Takeshita, "Nutritive Character & Quality Preservation in Rice Germ Oil" Tech. Rep. of Society for the Study of Food Quality Preservation, SQP 81-16, June (1981)
17) H. Yoshida & Y. Takeshita, "Lipid of Pearl Barley" Transact. of the Kokushikan Univ. Depart. of Eng. No. 16, p. 185 (1983)
18) A. Kato, "Research on Oryzanol", Kagakukogyoshiryo, **6**, (7), 107 (1971)
19) Y. Baba, K. Tachibana, "Inositol-Efficient Utilization of Defatted Bran", Yushi, No. 13 (197?); G. Kimura & Y. Inaba, Yukagaku, **12**, 69 (1963); G. Kimura & Noda, "Chem. of Inositol" J. of Org. Synth. Chem. **25**, (9), 764 (1967); G. Kimura, "Isolation of Inositol", Japan pat. 39-10122
20) G. E. Inglett, "Corn: Culture, Processing, Products", The AVI Pub. Co. Inc. Westport, Connecticut, (1970)
21) U. Myint Pe, "Parboiled Rice Bran as Source of Edible Oil in Burma. I, Storage of Stabilized and parboiled Rice Bran II, Processing problem", Contributed Papers, Rice By-products Conf. Valencia, Spain (1974), Topic III. p. 39
22) Y. Tsujino, "Preventing Method of ffa growing in Rice Bran" J. Japan Oil Chemists' Soc. (Yukagaku) **2**, 139, (1953)

穀物油脂製造工業技術の最近の進歩

竹 下 安日児

(工学部，化学教室 教授，工学博士・技術士)

要旨：米ヌカ油とパーム油の製造工業を発展させるために，ECAFE は 1970 年東京会議を開き，国連 UNIDO は米のセミナーを 1971 年マドラスで開催，この両会議に参加して，著者は当時の米ヌカ油工業技術の進歩を取りまとめて報告した。その後約10年を経た本年プラーグにおける Cereals '82 と称される穀物の国際会議で改めて穀物油脂工業の進歩について報告したので，この内容を中心に最近10年に生産規模の増大と共に生産技術の進歩が著るしかったことについて紹介し，討論する。